# Microplastic Contaminations in Buffet Food from Local Markets

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Received: 19 December 2019; Revised: 30 April 2020; Accepted: 20 May 2020

**Abstract**

Microplastics are environmental problems at global level, which can be primary environmental risks associated with food contaminations. Therefore, this study aims at determining contamination of microplastics in buffet food at three local markets in Ayutthaya and Pathum Thani, Thailand. This research investigated the contamination of microplastics in buffet food at three fresh markets. The results found the highest contamination 16 pieces/5g of tissue (wet weight) from mussel and fish tofu samples. The evaluation of consumption was consuming 1 kilogram of food could receive 3,200 microplastics of contamination that representing 13.01% from 11 types of microplastic. Moreover, the microplastic contamination also found the highest level in seafood (833±159 pieces/1 kg of tissue). Approximate 40.65% of the food products from the delicatessen type and products from meat were contaminated the microplastic by average 30.89% and 28.46%, respectively. Most microplastic contamination shad blue color and consisted of multiple types of microplastic, including fibers, fragments, microbeads, rods and pellets, respectively. Consequently, the presence of microplastics in buffet food especially in seafood should be concern about the potential effect of microplastics on human health, impact on food safety and socio economic wellbeing. This research obtained data that will be useful for consumers to consider options of the buffet food and to reduce health risk in long-term.

**Keywords:** microplastic, buffet food, food contamination, plastic packaging, plastics

## Introduction

At present, the market share of plastic product takes 8% of the total global oil products. Burning the plastic will release more than 4,000 toxic fumes, which 80% of them are carcinogens. Only 7% of total plastic has been recycled and the remaining of plastic wastes are either disposed to environment (Khan, Chettri, & Lakhala, 2008). Plastic products are difficult to be degraded or very slowly natural decomposing. Some plastic such as plastic bags takes 450 years to be completely decomposed while Styrofoam never be degraded. Recycling rate of plastic products are short-time on using and plastic has become indispensable for human life. Bangkok Metropolis, Thailand has reported solid wastes generating about 1 kg per person per day, which accumulated annual wastes residual to be 400,000 tonnes. In 2015, total plastic packaging was used 2.048 tonnes, comprising of plastic bags, foam boxes and others for 0.476, 0.090 and 1.482 tonnes, respectively (Kittipongvises, Phetrak, Lohwacharin, & Polprasert, 2019). Itis not impossible to eliminate plastics. Consequently, plastic accumulation in the environment is increasing due to low degradation rates coupled with unsustainable use and disposal. Solar Impulse Foundation (2018) reported that plastics could be categorized into primary plastics and secondary plastics by the degradation of primary ones. They can also be defined by their sizes: microplastics (small particles (<5 mm) of plastics dispersed in the environment) and macroplastics. In addition, because plastic is such a persistent material, the ecological economic and eco-toxicological effects of plastic pollution are all log-term. For example, physical and chemical impacts on marine life, such as entanglement, starvation, ingestion and the buildup of persistent organic pollutants like PCBs or DDT, and economic impact as damage to fisheries, shipping and tourism, including transport of invasive species and pollutants from polluted rivers to remote areas in the ocean (The Ocean Cleanup, 2019).

The primary environmental risks associated with microplastics are their bioavailability for aquatic biota such as fish, shrimp, crab, squid and mussel (Li, Yang, Li, Jabeen, & Shi, 2015). The bioavailability of microplastics depends on their size, density, abundance, shape, and color (Wright, Thompson, & Galloway, 2013). Since microplastic is bioavailable to the smallest of organisms. It may be transferred through the food web (Prinz & Korez, 2019). Microplastics contaminate at every level of aquatic food chains, which increases the concern for microplastic to reach higher trophic levels including humans (Li et al., 2015; Watts et al., 2014; Farrell & Nelson, 2013). Microplastics are widely found in shellfish species, blue mussel (*Mytilus edulis*) and oysters (*Crassostrea gigas*), which are consumed for seafood. A study showed that the maximum numbers of microplastics were found in mussels at Halifax Harbor (Nova Scotia, Canada) 34-75 particles/animal (Hantoro, Lö hr, Van Belleghem, Widianarko, & Ragas, 2019). Bivalves were collected from a fishery market in China. They contained the number of total plastics 2.1-10.5 items/g and 4.3-57.2 items/individual for bivalves (Li et al., 2015). Fish from coastal areas of China were found highest number of microplastics 1.1-7.2 particles/animal (Hantoro et al., 2019). Moreover, Ocean is an important source of seafood, which is the most commercially popular for buffet seafood at fresh market of Thailand.

Thailand has various types of buffet food, such as Japanese buffet, international cuisine and Thai food, because eating habits of Thai people prefer party in group. So, buffet food trends are favor in both eat out and at home styles. The main dish of buffet food includes seafood, meat food, and delicatessen products for main ingredients. For this reason, the buffet shop owners who are selling buffet food at local markets should concern in health of consumers. Because microplastic contamination in raw materials may cause adverse health effect on consumers in long-term. In this study, the samples were collected by sampling 11 most favor in gradients for buffet food from three local markets in Ayutthaya and Pathum Thani, Thailand. Then the abundance and types of plastics were measured. This study aims at determining the contamination of microplastics in buffet food at local markets.

## Methods and Materials

### Sample Collection

Eleven types of fresh and delicatessen products were sampling from the buffet food shops at three local markets during September–October, 2019, which were located in Ayutthaya and Pathum Thani, Thailand. The code was defined as followings: Market 1 (M1) located at N 14°13′87″and E 100°61′70″, Market 2 (M2) located at N 14°14′93″ and E 100°62′79″and Market 3 (M3) located at N 14°14′55″ and E 100°61′51″.These fresh and delicatessen products were existed in the most favorite menus of students and working age people. These ingredients of six from twelve shops at local markets were observed. The selected shops allowed to interview 100 people by asking them the questions about selecting food types and shops for buffet food.Eleven types of samples comprised of seafood, meat, and delicatessen products: white shrimp, fresh squid, crisp squid, mussel, beef, pork, dolly fish fillet, fish tofu, crap stick, hot dog and bacon, with three times in total 33samples.These all samples could be found in traditional food of local people, and were found to be served and contained in recipes of buffet food all the time.

**Sample Analysis**

Sample analysis in this study was applied from Mathalon & Hill (2014) and Li et al. (2015). The samples were cleaned by distilled water at laboratory and all of the same samples were prepared in one glass container and repeated for three replicate for each ingredient. Then 5 g wet weight of the samples were shredded and put separately into beakers. Approximately 25 ml of 30% hydrogen peroxide ($H_2O_2$) was used to digest the organic matter depending on the weight of the soft tissue in each beaker. The beakers were placed on hot plates at 55-65$^{o}$C until all $H_2O_2$ was evaporated, and then leaved at room temperature for 24-45 hours (h), depending on the digestion effect of the soft tissue. A concentrated saline solution (250 g NaCl/L) was prepared to separate the microplastics from dissolved liquid of the soft tissue via floatation by adding 25 ml of NaCl solution to each beaker. The liquid was mixed by magnetic stirrer at high intensity for 1-2 minutes (min) and retained overnight for settling. The sample solution was directly filtered over a 5 mm pore size, 70 mm diameter cellulose membrane filter (Fioroni No. 601A) through a vacuum system. The remaining substances on the filter paper were placed into clean petri dish with a cover and observed under a Reliable Greenough Stereo Microscope (ZEISS, Stemi508). The images were taken by AxioCam digital camera. A visual assessment was applied to identify the types of microplastics according to the physical characteristics of particles.

## Results

The results of microplastic contaminations in 11 types of buffet food from 3 local markets (M1-M3) found maximum contamination 16 pieces/5g of tissue (wet weight) in samples of mussel and fish tofu. For the consuming evaluation, consuming 1 kilogram (kg) of buffet food, people may receive a total of 3,200 microplastics contamination (mean value 1,067$\pm$305.51pieces from mussel and 1,067$\pm$115.47 pieces from fish tofu), which represented 13.01% from all 11 types of microplastic. The results found amount of microplastics 13 pieces (10.57%) from each dolly fish fillet and beef products, while the least contamination4.07% of microplastics was found in hot dog (Table 1).

**Table 1** Results of microplastic contaminations in buffet foods (wet weight) from three local markets

| Type of Buffet Food | Amount of Microplastics (pcs/5g) | | | | Total | Mean (SD), | Percentage |
|---|---|---|---|---|---|---|---|
| | M1 | M2 | M3 | Total | (pcs/kg) | n=3(pcs/kg) | (%) |
| White shrimp | 6 | 1 | 5 | 12 | 2,400 | 800 | 9.76 |
| Fresh squid | 3 | 3 | 5 | 11 | 2,200 | 733 | 8.94 |
| Crisp squid | 3 | 3 | 5 | 11 | 2,200 | 733 | 8.94 |
| Mussel | 5 | 7 | 4 | 16 | 3,200 | 1,067 | 13.01 |
| Dolly fish fillet | 2 | 3 | 8 | 13 | 2,600 | 867 | 10.57 |
| Sliced pork | 2 | 4 | 3 | 9 | 1,800 | 600 | 7.32 |
| Sliced beef | 9 | 4 | 0 | 13 | 2,600 | 867 | 10.57 |
| Fish tofu | 5 | 6 | 5 | 16 | 3,200 | 1,067 | 13.01 |
| Crab stick | 3 | 0 | 3 | 6 | 1,200 | 400 | 4.88 |
| Hot dog | 0 | 5 | 0 | 5 | 1,000 | 333 | 4.07 |
| Bacon | 0 | 10 | 1 | 11 | 2,200 | 733 | 8.94 |
| Net total | 38 | 46 | 39 | 123 | 24,600 | 8,200 | 100.00 |
| Mean, n=11 | 3.45 | 4.18 | 3.55 | 11.18 | 2,236.36 | 745.45 | |
| Standard deviation | 2.66 | 2.79 | 2.46 | 3.56 | 703.23 | 234.60 | |

The amount of microplastics in seafood group (shrimp, fresh-crisp squids, mussel) was higher than in meat (dolly fish fillet, pork, beef), and delicatessen products (fish tofu, crab stick, hot dog, bacon) as followed average 833 (40.65%), 633 (30.89%) and 778 (28.46%) pieces/ 1 kg of food, respectively. An abundance of microplastics in each buffet food groups were 39% in both beef and fish tofu of delicatessen products higher than 32% in mussel of seafood (Figure 1).

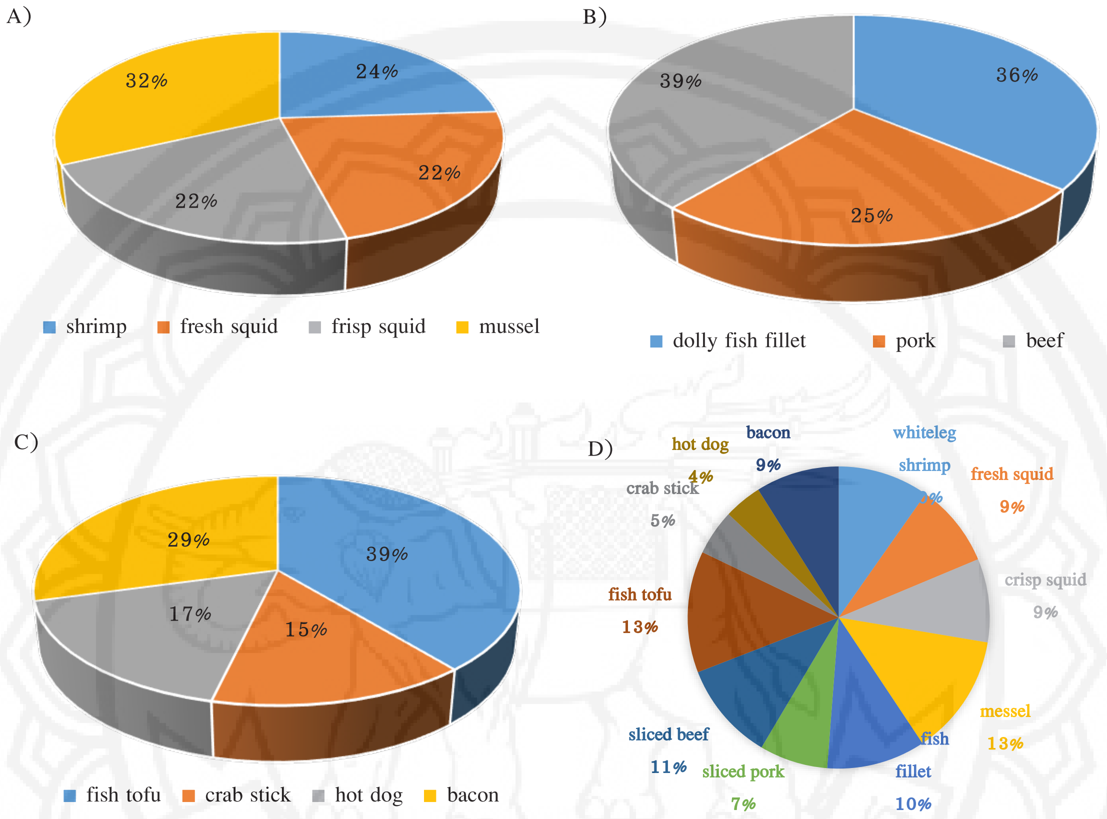


**Figure 1** The percentages of microplastic contaminations in buffet food; A) seafood, B) meat, C) delicatessen products and D) total contamination of microplastics, from three local markets

Types of microplastic contaminations in seafood, meat and delicatessen products of buffet food were found multiple types of microplastics, including fibers, fragments, microbeads, rods and pellets which found 57.72%, 22.76%, 10.57%, 7.32% and 1.63%, respectively (Table 2). The diverse colors were observed multiple types of microplastics, which were blue color more than other colors; back, red, yellow, green, pink, violet, white and transparent (Figure 2).

**Table 2** Type of microplastic contaminations in buffet food

| Parameters | Types of Microplastic in Buffet Food | | | | |
|---|---|---|---|---|---|
| | Fibers | Pellets | Fragments | Microbeads | Rods |
| Total | 71 | 2 | 13 | 28 | 9 |
| Percentage | 57.72 | 1.63 | 10.57 | 22.76 | 7.32 |
| Mean (n=11) | 6.5 | 0.2 | 1.2 | 2.5 | 0.8 |
| SD | 1.60 | 0.42 | 0.63 | 0.57 | 0.92 |

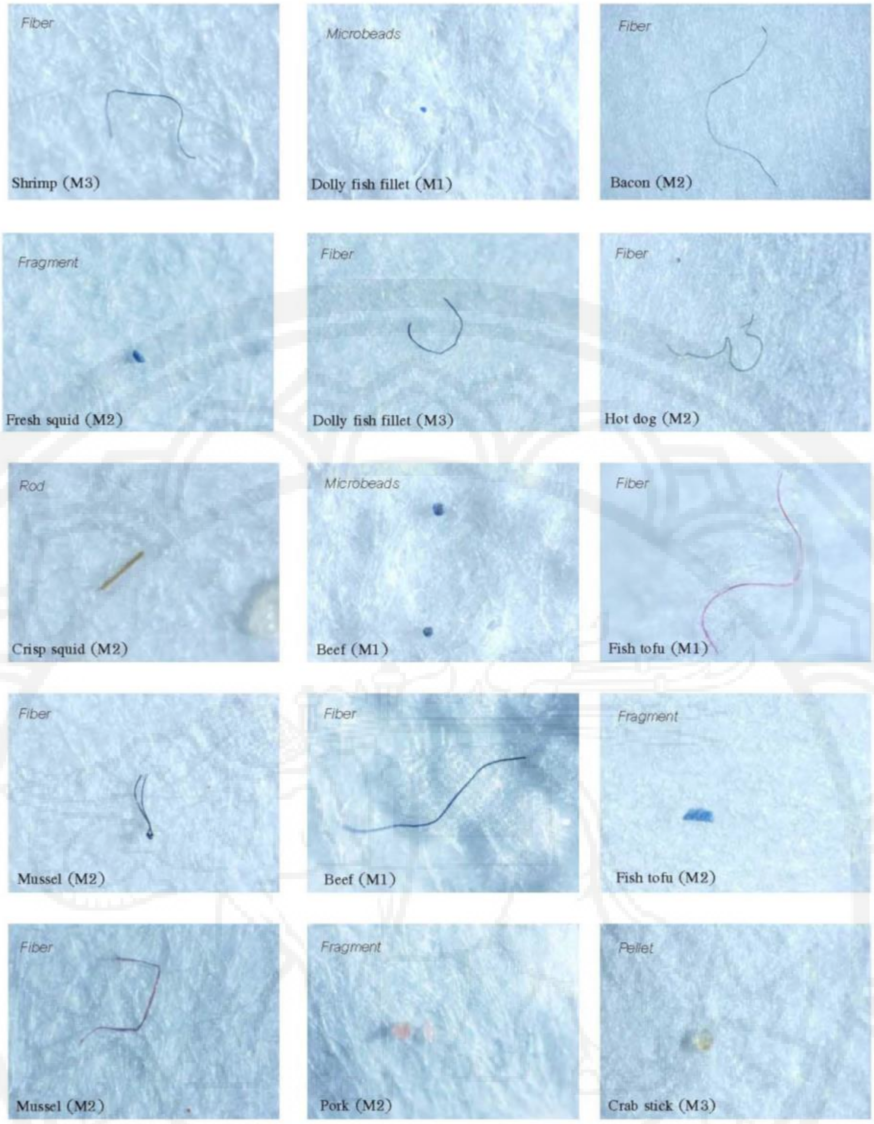


**Figure 2** Photographs of multiple types of microplastics, including fibers, fragments, microbeads, rods and pellets in buffet food from three local markets (M1-M3)

## Discussion

The results of microplastic contaminations in buffet food from markets were found highest contamination in mussel and fish tofu, representing 13.01% from all 11 types of microplastic. The amount of microplastics in seafood group were higher than in meat and delicatessen products, respectively. The main route for microplastic contaminations in food products originated from habitat environment, which could be found typically only very small numbers of plastic particles in the food products. Also, a typical food chain composed of many different intermediate food processing per treatment per distribution steps, and each step could potentially cause contamination by microplastics (Toussaint et al., 2019). In Thailand, the coastal areas are important sources of seafood and most commercially popular for buffet seafood from fresh market. Discarded plastic material entered the marine environment. In long term, plastic particles contaminated the marine ecosystem and the food chain, including foodstuffs (Lusher, Hollman, & Mendoza-Hill, 2017).

The current study found maximum contamination in mussel and fish tofu. Most species of bivalves and several species of small fish are generally consumed, so it may lead to microplastic exposure. There are two main ways for marine organisms to ingest microplastics: direct ingestion from the natural environment and indirect ingestion, including trophic transfer from prey and consumption of contaminated aquaculture feedstock (Toussaint et al., 2019). Report of the EFSA (2016) indicated that the common mussel (*Mytilus* edulis), cultivating for human consumption, can ingest microplastic particles with sizes ranging from 2 to 10 micrometer and in mussel 0.2 to 4 pieces per gram. According to this study, we found quantity of microplastics in mussel 4 to 7 pieces per 5 grams (0.8 to 1.4 pieces per gram). However, microplastics number in mussel of this study was less than other studies that found 2.1 to 10.5 pieces per gram of total microplastics in blue mussel (*Mytilus edulis*) from the fish market (Li et al., 2015; Walkishaw, Lindequ, Thompson, Tolhurs, & Cole, 2020). Results of dissimilar contaminations of the bivalves ingested microplastics preferentially, based on the physical characteristics of the plastic species (size and shape), feeding behavior, and size of organism (Ward et al., 2019). A risk assessment base on the case estimate of exposure to microplastic in human consumption of seafood (fishes, mussels and oysters) reported to have 0.36-0.47 particles of microplastic per gram, meaning that seafood consumers could invest up to 11,000 particles of microplastic per year depending on seafood consumption habits and exposure of organisms to microplastics (Aparna, 2019). Moreover, it has been concern that microplastics may leach additive or adsorbed chemical contaminants in to human upon ingestion the estimated chemical exposure to human of persistent and plastic additives following of buffet food.

This study found that an abundance of microplastics in each buffet food groups were 39% in both beef meat and fish tofu of delicatessen products higher than 32% in mussel of seafood. Therefore, microplastic contaminants were widespread and showed variation between the types of buffet food collected from the three local markets. Types of microplastic contaminations were found multiple types of microplastics, including fibers, fragments, microbeads, rods and pellets, respectively. The diverse colors were observed multiple types of microplastics, which were blue color more than other colors. Overall, the fibers and pellets were usually transport and blue colors. According to Tharamon, Prasisanklul, and Leadprathom (2016) reported that the most prevalence type of microplastic in bivalve was highest fibers (82.3%) in Chaolao beach and was blue color (25.29%) in Kungwinan beach of Thailand. Similar to Li et al. (2015) showed that fibers were the most common microplastics and consisted of more than half of the total microplastics in each of the 8 commercial bivalves.

## Conclusion

The study assessed the microplastics in the buffet food and found relatively highest in mussel and fish tofu, while the least contaminated microplastics was found in hotdog from all 11 sampling food types. The amount of microplastics in the seafood group (shrimp, fresh-crisp squids, mussel) were higher than in meat (dolly fish fillet, pork, beef) and delicatessen products (fish tofu, crab stick, hot dog, bacon). The most common microplastic type was fiber, which was found in blue color more than other colors. The results indicated the buffet food consumption was one pathway for human microplastic exposure and risk to human health. Therefore, the contamination of buffet food by microplastics concerns the food safety and human health. However, the potential and adverse effect of microplastics on human health are still controversial and not well understand.

Therefore, the future research on the effect of microplastic pollution on human health and food safety are necessary for providing risk assessment.

**Acknowledgments**

The authors would like to express their gratitude to Environmental Science and Technology Program, Faculty of Science and Technology for student laboratory assistant jobs, and Research and Development Institute, Valaya Alongkorn Rajabhat University under the Royal Patronage, Thailand for financial support.

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